68002 – 583.5 grams
68001 – 840.7 grams

Double Drive tube

61 cm

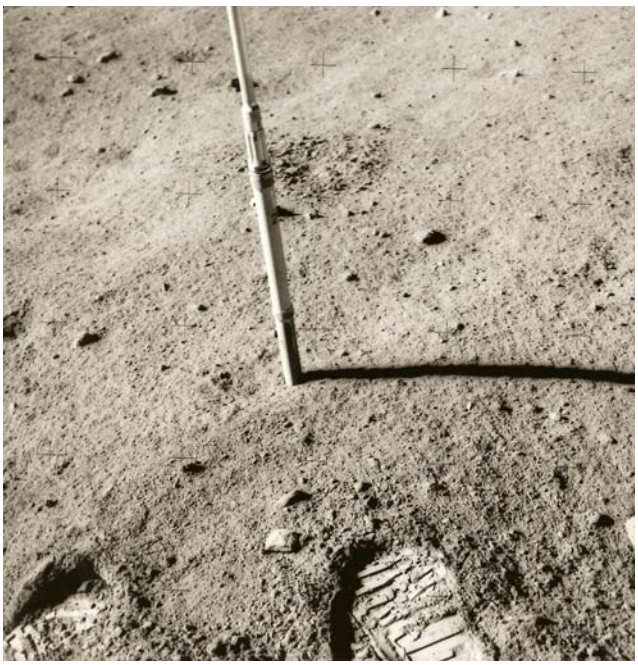


Figure 1a: Surface photo for double drive tube 68001-2. AS16-108-17684.

Figure 1b: All the way in for double drive tube. AS16-108-17686

Introduction

Station 8 was the closest to South Ray Crater so pre-mission planning expected to sample a layer of material from South Ray crater on top of material derived from the Cayley formation (figure 1 and 2). However, after analysis it was concluded that the whole length of the core is Cayley.

Double drive tube 68002/1 was pushed in about 18 cm and then driven in to a depth of 69 cm with about 56 hammer blows (Mitchell et al. 1972). About 61 cm of core were returned (see section on 68002 for picture of entire core).

The bulk soil samples from the lunar surface that were taken closest to this core were 68120 and 68500.

Petrography

According to the preliminary science report (Horz et al. 1972), the lowest 22 cm of the core, called unit 1 (later called unit D), is very coarse grained. They even speculate that "the top of this zone may represent a buried topographic surface" (page 7-43). However, this study was based on an interpretation of the X-radiograph, and was not confirmed by the study of the core after extrusion. Schwarz (1994) described the samples during dissection – see end of this section.

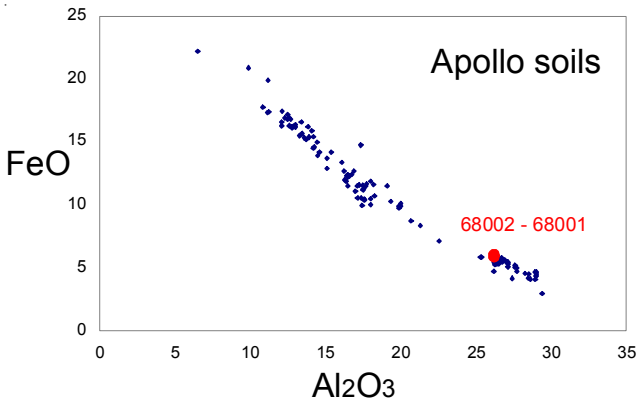


Figure 2: Composition of 68002 compared with other Apollo soils.

The maturity index along the double drive tube is shown in figure 3. The upper portion of the core is

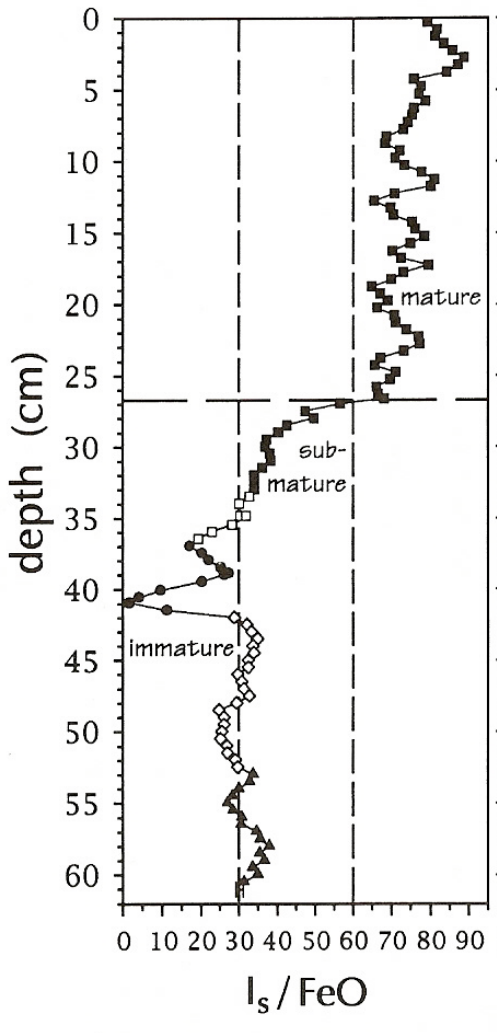


Figure 3: Maturity index as function of depth in 68002/1 double drive tube (Korotev et al. 1997).

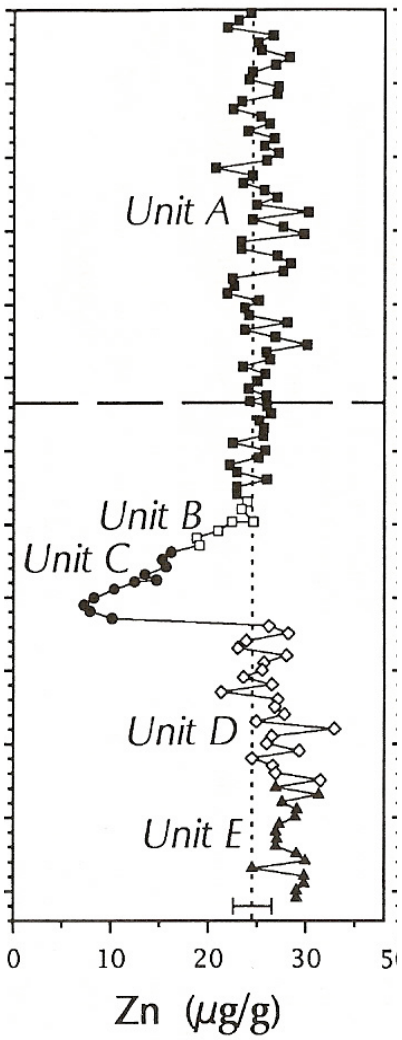


Figure 4: Low Zn was found in units B and C.

made up of mature soil, while the bottom section is submature except for a thin zone at about 41cm which is very immature.

Korotev et al. (1997) studied thin sections of units B, C and the top of D, where they found the agglutinate count did not correlate with the zone of low maturity. Unit C is describe as bluish-grey soil and the subject of much discussion in Korotev et al., who conclude it is indeed a soil.

Schwarz (1995) and Ruzitka et al. (2000) reported on the occurrence of glassy chondrules with unique crystal formations (figure 5).

The numerous particles extracted during dissection have not been studied (some examples are shown in figures 7 - 11. One large particle (16 g) at the top of 68002 has two thin sections.

Chemistry

Korotev et al. (1997) exhaustively analyzed 123 splits from the entire length of the double drive tube. They found that there were 5 different zones along the core, base on compositional data, and averaged the results for each zone (table 1). For a complete analysis of the regolith at this site see section on 68500.

The immature zone at about 41 cm was found to have very low Zn (figure 4).

Processing

68001 was dissected in 1993 (figure 6) and discussed in curatorial newsletters 55, 56 and 58. Compression of the core during extrusion was only minor. Some

samples were split under "red light" conditions. The numerous coarse-fines have never been cataloged, nor studied.

There are three sets of thin sections along the whole core.

The following from Schwarz 1993, in Lunar News vol. 55 and 57:

"68002 was extruded from the drive tube on Feb 17, 1993. The color was determined to be 10YR 5/1 on the Munsell color scale and no distinct color boundaries were observed during dissection. A void was present from the lunar surface to about 3.5 cm. The top 4 cm was loose and below that the soil was noticeably more coherent. Friable soil clods were abundant from 9.5 to 14.5 cm from the lunar surface.

A close examination of particles > 1 mm from the first dissection pass showed that about 84% (by number) of the particles are in the 1-2 mm size range, 15% were 2-4 mm, 1% were 4-10 mm and less than 1% were > 10 mm.

Lithology of the >1 mm fraction was determined by binocular microscopic examination of the particles from the first pass and is summarized as follows: 57% are various types of breccias, 15% are glasses including glass shards, agglutinates, and glass-coated breccias, 14% are dark, coherent, and often dusty, 12.5% are white or light grey (anorthositic), and about 1.5% are basalts. Sub-sample ,44 (1.395 g) a dusty, possibly metallic, irregular-shaped piece, was extracted from 7.7-8.5 cm interval. A large anorthositic (?) fragment, located at 0.4 – 3.4 cm from the lunar surface was uncovered and numbered after the completion of the third pass."

and

"68001 was extruded on Dec 14, 1993. The length of extrusion was 34.1 cm; thus the total length of 68002/1 was 61 cm. The color of 68001 varied from 10YR 5/1 to 7/1 on the Munsell Color Scale and several distinct color boundaries were observed during dissection passes. A void at the top end extended to about 1.5 cm. At 0 to about 9 cm was a dark layer, approximately 10YR 5/1. Dark soil breccias and soil clods were abundant and varied from small at the top to larger toward the lower end of the core. Black fine-grained glassy particles are abundant as well as some glass and anorthosites. From about 9 to 12.5 cm is a layer of lighter gray soil (10YR 7/1) characterized by light gray clods/soil breccias which dominate the >1 cm fraction.

Anorthosites are rare and small black glassy particles are fairly numerous. At 12.5 cm and continuing to about 15 cm is a darker slightly bluish-gray layer. The >1 mm fraction consists of all coherent particles, they are generally small black glassy pieces, and breccias with a few anorthosites and glass.. At about 15 cm the soil becomes a brownish-gray color (10YR 6/1) and is noticeably loose and coarse-grained > 1 mm particles are numerous and all are coherent (no friable soil breccias). A finger of light gray material extends about two thirds of the diameter of the core at about 18-18.5 cm with obvious mm-sized white fragments occurring. From about 21.5 cm and continuing to the bottom of the core is a lighter-colored zone of soil which is more coherent and whose > 1 mm portion is rich in soil breccias (both clods and coherent breccias) and black glassy fine-grained fragments.

A closer examination of particles > 1 mm from the first and second dissection passes showed that about 81% (by number) of the particles are in the 1-2 mm size range, 18% were 2-4 mm, and 1% were 4-10 mm or > 10 mm.

Lithology of the >1 mm fraction was determined by binocular microscopic examination of the particles from the first and second passes and is summarized as follows, 47% are various types of breccias an dusty fragments which were difficult to indentify, 27% are black-fine-grained glassy fragments, about 10% are white or light gray (anorthositic), 6% are glasses, and <1% are basalts> Among the 20 large or unusual particles > 1 mm which were given sample numbers are soil breccias, black glassy fragments, white fragments, and a small soil clod with a rusty-looking spot. Three samples of about 0.5 grams each were taken under red-light conditions from the depths of approximately 10, 20 and 30 cm."

List of Photo #s
AS16-108-17682-17686
S93-42039
S94-39981

Table 1. Chemical composition of 68001.

unit	A	B	C	D	E	all
reference	Korotev97					ave
depth	0 - 33 cm	33 - 37 cm	37 - 42 cm	42 - 53 cm	53 - 61 cm	0 - 61 cm
SiO2 %						
TiO2						
Al2O3						
FeO	5.61	5.36	5.4	5.31	5.65	5.53
MnO						
MgO						
CaO	15.2	15.6	15.6	15.2	15.1	15.2
Na2O	0.455	0.453	0.446	0.455	0.461	0.454
K2O						
P2O5						
S %						
sum						
Sc ppm	9.52	9.39	9.17	9	9.71	9.41
V						
Cr	789	779	779	754	783	781
Co	33.1	27	31	29.8	31.1	31.7
Ni	479	375	443	440	451	459
Cu						
Zn	25	22	12	26	28	24
Ga						
Ge ppb						
As						
Se						
Rb						
Sr	181	169	181	176	179	179
Y						
Zr	198	172	192	199	205	197
Nb						
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm	0.13	0.13	0.12	0.15	0.15	0.14
Ba	149	133	144	150	157	149
La	13.9	12.8	13.8	14.3	15	14.1
Ce	36.1	33.1	35.8	37.2	38.8	36.8
Pr						
Nd						
Sm	6.44	5.91	6.36	6.62	6.9	6.5
Eu	1.21	1.15	1.19	1.2	1.22	1.21
Gd						
Tb	1.32	1.18	1.27	1.36	1.41	1.33
Dy						
Ho						
Er						
Tm						
Yb	4.52	4.13	4.43	4.6	4.82	4.54
Lu	0.627	0.577	0.619	0.643	0.677	0.633
Hf	4.85	4.84	4.35	4.67	4.93	5.16
Ta	0.58	0.52	0.56	0.58	0.61	0.58
W ppb						
Re ppb						
Os ppb						
Ir ppb	15.2	10.8	14.1	12.4	12.6	14
Pt ppb						
Au ppb	0.5	6.9	8.6	8.3	8.8	9
Th ppm	2.3	2.1	2.24	2.32	2.46	2.31
U ppm	0.61	0.55	0.58	0.6	0.64	0.61

technique: (a) INAA

References for 68001, 68002.

Butler P. (1972a) Lunar Sample Information Catalog Apollo 16. Lunar Receiving Laboratory. MSC 03210 Curator's Catalog. pp. 370.

Duke M.B. and Nagle J.S. (1976) Lunar Core Catalog. JSC09252 rev. Curators' Office

Fryxell R. and Heiken G. (1974) Preservation of lunar core samples: Preparation and interpretation of three-dimensional stratigraphic sections. *Proc. 5th Lunar Sci. Conf.* 935-966.

Hörz F., Carrier W.D., Young J.W., Duke C.M., Nagle J.S. and Fryxell R. (1972) Apollo 16 special samples. In Apollo 16 Preliminary Science Rpt. NASA **SP-315** page 7-24 to 7-54

Korotev R.L., Morris R.V., Jolliff B.L. and Schwarz C. (1997) Lithological variation with depth and decoupling of maturity parameters in Apollo 16 regolith core 68001/2. *Geochim. Cosmochim. Acta* **61**, 2989-3002.

LSPET (1972c) Preliminary examination of lunar samples. Apollo 16 Preliminary Science Report. NASA SP-315, 7-1—7-58.

LSPET (1973b) The Apollo 16 lunar samples: Petrographic and chemical description. *Science* **179**, 23-34.

Mitchell J.K., Carrier W.D., Houston W.N., Scott R.F., Bromwell L.G., Durgunoglu H.T., Hovland H.J., Treadwell D.D. and Costes N.C. (1973) 8. Soil-Mechanics. *In* Apollo 16 Preliminary Science Rpt. NASA SP-315. pages 8-1-29.

Muehlberger W.R., Horz F., Seiver J.R. and Ulrich G.E. (1980) Mission objectives for geological exploration of the Apollo 16 landing site. *In* Proc. Conf. on **Lunar Highlands Crust**, 1-49 (eds. Papike and Merrill). Lunar Planetary Institute, Houston.

Ruzicka A., Snyder G.A. and Taylor L.A. (2000) Crystal-bearing lunar spherules: Impact melting of the Moon's crust and implications for the origin of meteoritic chondrules. *Meteor. & Planet. Sci.* **35**, 173-192.

Schwarz C., Morris R.V. and Korotev R.L. (1994) Preliminary description of double drive tube 68002/1 (abs). *Lunar Planet. Sci.* **XXV**, 1223.

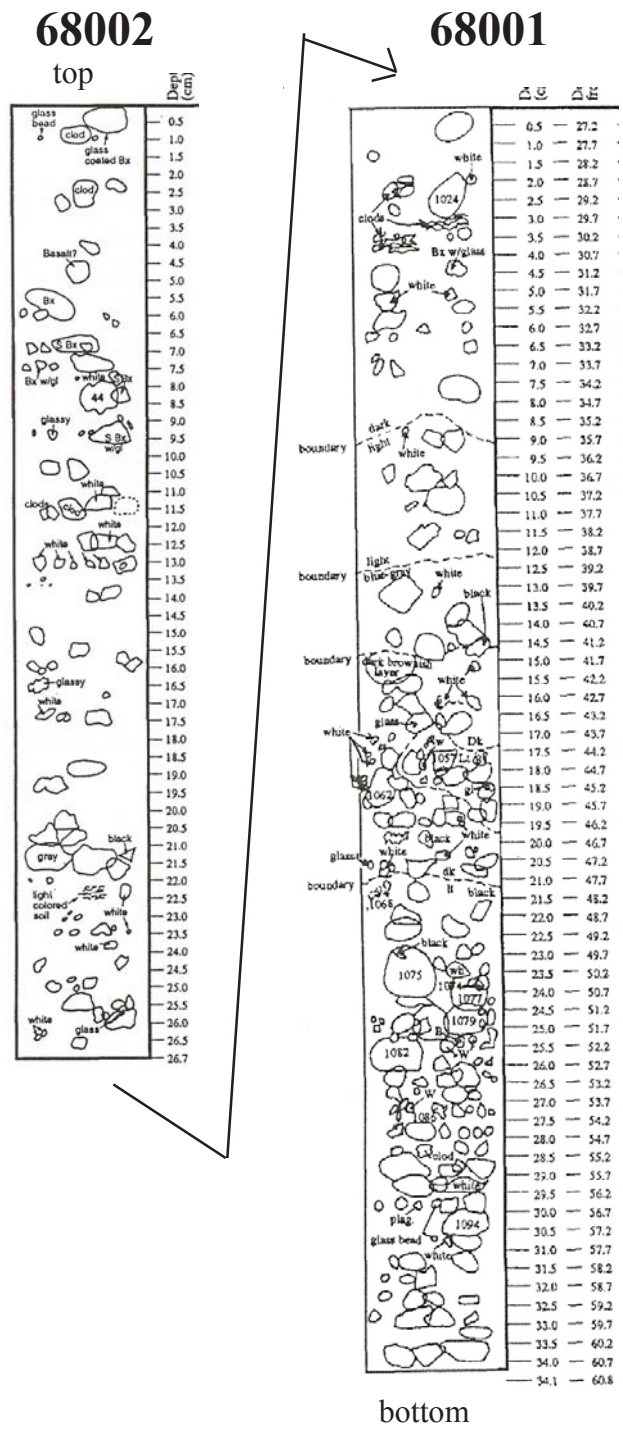
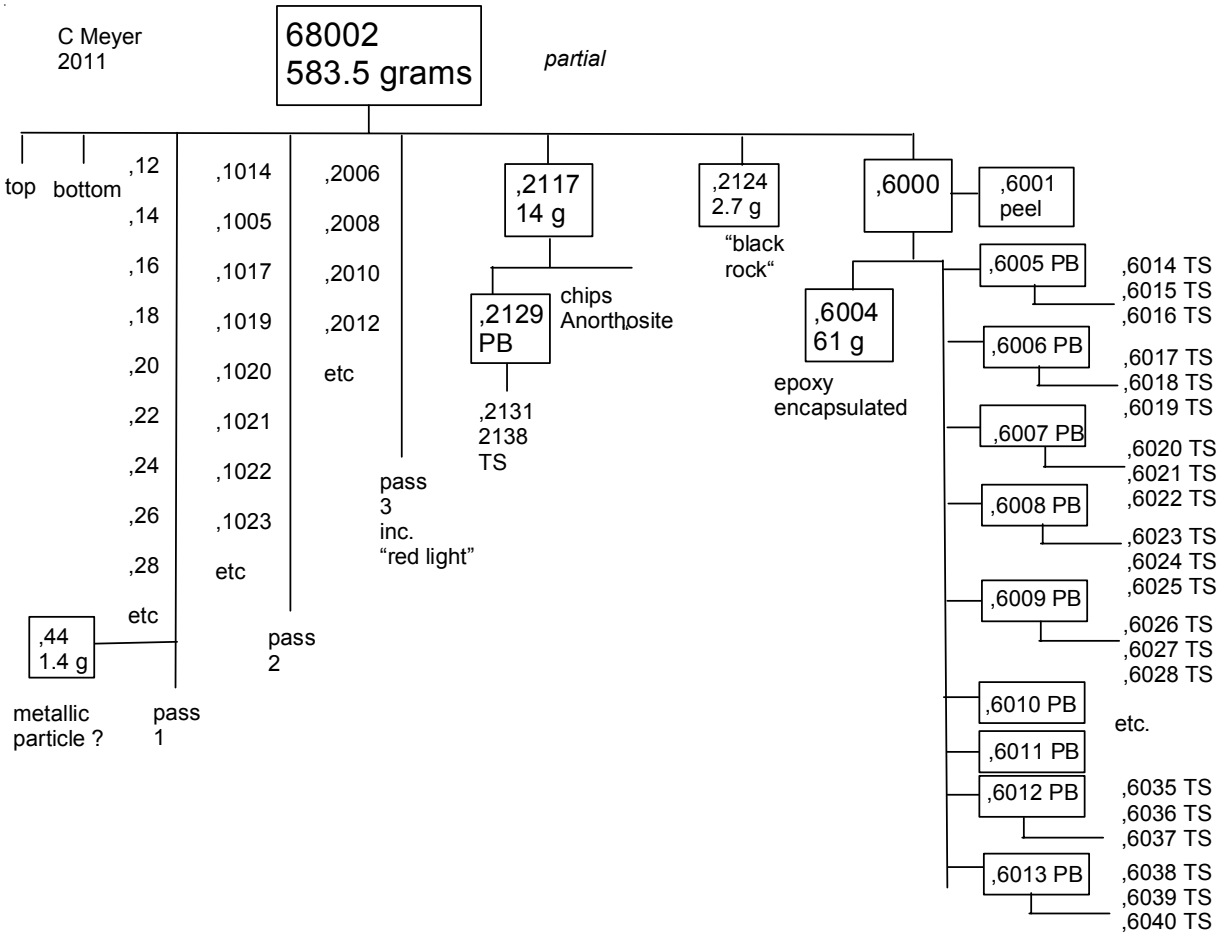
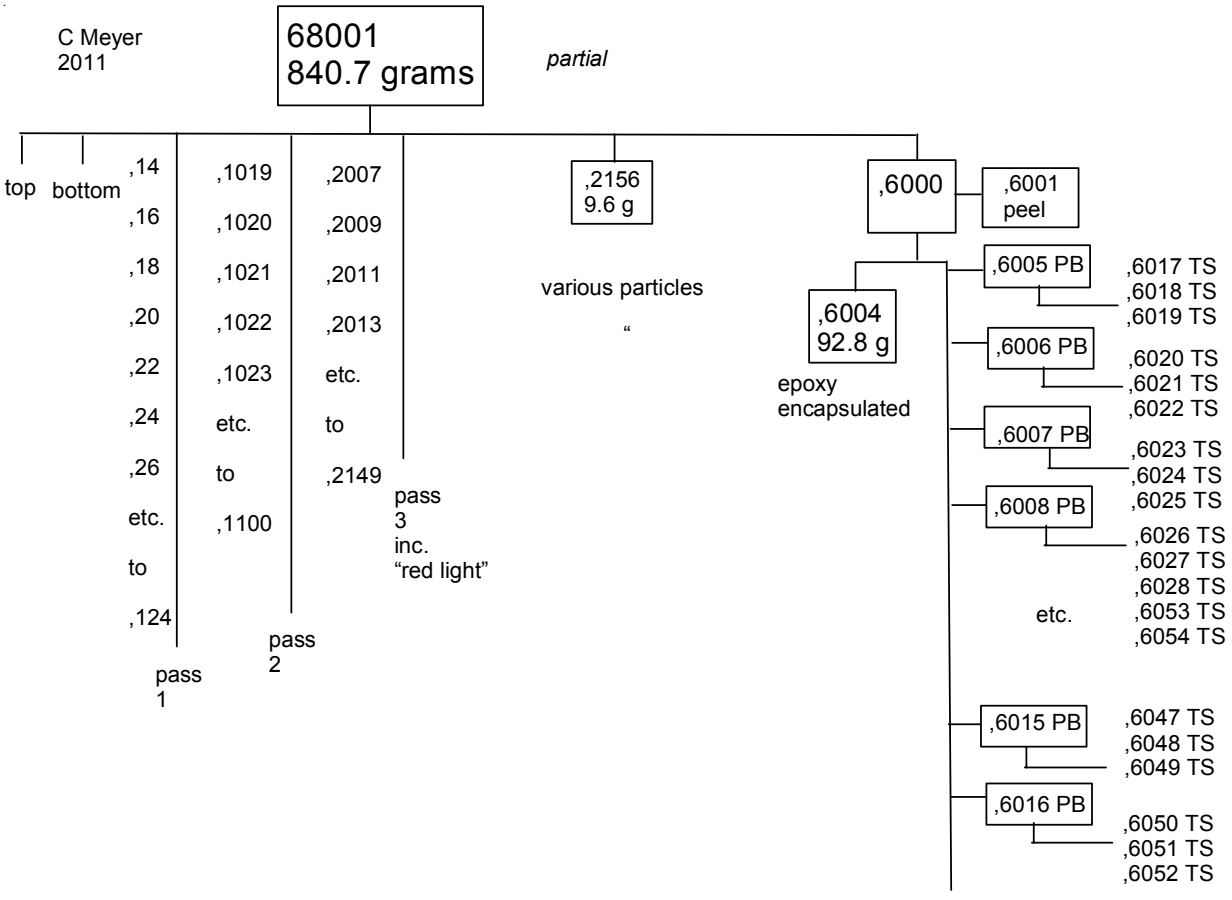


Figure 6: Sketch of core from dissection (Schwarz 1993).


C Meyer
2011
68002
583.5 grams
partial
top
bottom
,12
,14
,16
,18
,20
,22
,24
,26
,28
etc
,44
1.4 g
metallic
particle ?
pass
1
,1014
,1005
,1017
,1019
,1020
,1021
,1022
,1023
etc
pass
2
,2006
,2008
,2010
,2012
etc
pass
3
inc.
“red light”
,2117
14 g
,2129
PB
chips
Anorthosite
,2131
2138
TS
,2124
2.7 g
“black
rock“
,6000
,6001
peel
,6004
61 g
epoxy
encapsulated
,6005 PB
,6006 PB
,6007 PB
,6008 PB
,6009 PB
,6010 PB
,6011 PB
,6012 PB
,6013 PB
,6014 TS
,6015 TS
,6016 TS
,6017 TS
,6018 TS
,6019 TS
,6020 TS
,6021 TS
,6022 TS
,6023 TS
,6024 TS
,6025 TS
,6026 TS
,6027 TS
,6028 TS
etc.
,6035 TS
,6036 TS
,6037 TS
,6038 TS
,6039 TS
,6040 TS


C Meyer
2011
68001
840.7 grams
partial
top
bottom
,14
,16
,18
,20
,22
,24
,26
etc.
to
,124
pass
1
,1019
,1020
,1021
,1022
,1023
etc.
to
,1100
pass
2
,2007
,2009
,2011
,2013
etc.
to
,2149
pass
3
inc.
“red light”
,2156
9.6 g
various particles
“
,6000
,6001
peel
,6004
92.8 g
epoxy
encapsulated
,6005 PB
,6006 PB
,6007 PB
,6008 PB
,6015 PB
,6016 PB
,6017 TS
,6018 TS
,6019 TS
,6020 TS
,6021 TS
,6022 TS
,6023 TS
,6024 TS
,6025 TS
,6026 TS
,6027 TS
,6028 TS
etc.
,6053 TS
,6054 TS
,6047 TS
,6048 TS
,6049 TS
,6050 TS
,6051 TS
,6052 TS

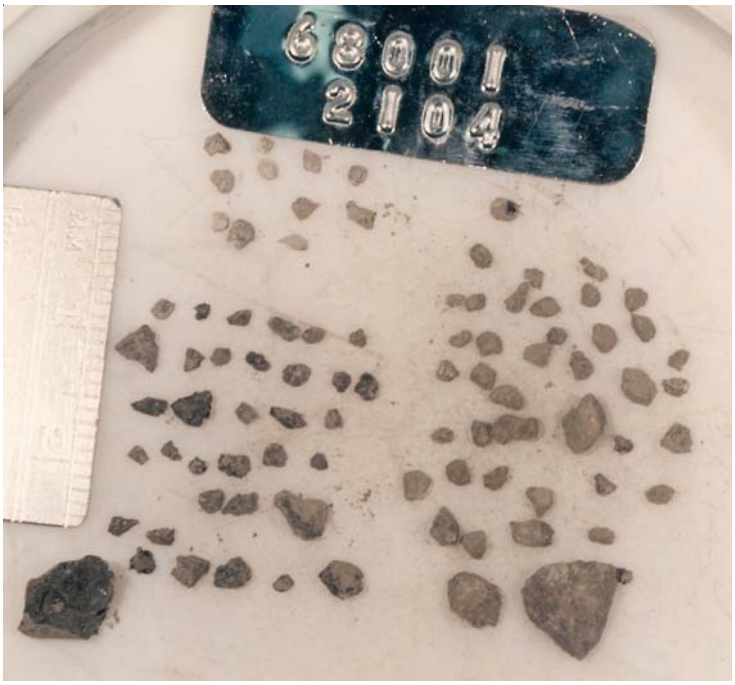


Figure 7: Particles sieved from 68001,2004. Scale is 2.5 cm. S94-34010

Figure 8: Particles sieved from 68001,2117. Larges particles is 4 mm. S94-34009

Figure 9: Particles sieved from 6002,39. Largest particles is 8 mm. S93-30579.

Figure 10: Particle picked from core 68001,2156. S94-34948.

Figure 11: Two glass beads 68002, 1016 (bottom) and ,1018 (top). S93-35358.